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Assessment of Risk Caused by Remedial Actions Considered for Vertac Chemical Corporation Site, Jacksonville, Arkansas

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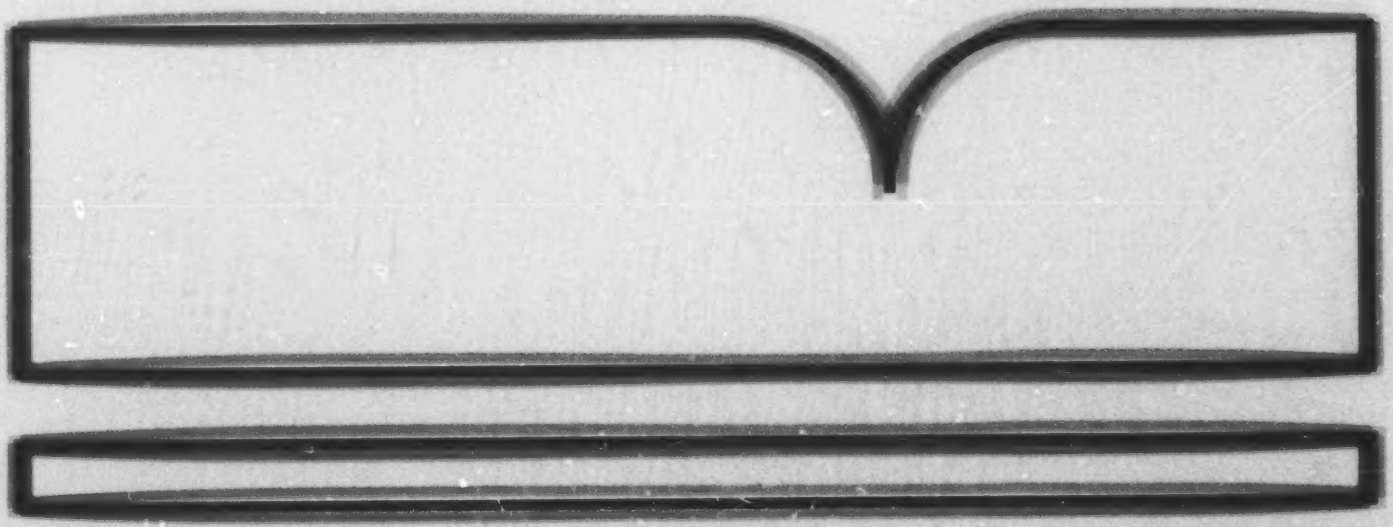

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ASSESSMENT OF RISK CAUSED BY REMEDIAL ACTIONS CONSIDERED FOR VERTAC CHEMICAL CORPORATION SITE, JACKSONVILLE, ARKANSAS*

By

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16. ABSTRACT

The purpose of this study is to assess the risk caused by dust emissions associated with proposed remedial actions considered for the Vertac Chemical Corporation site in Jacksonville, Arkansas. Much of the site is contaminated with 2,3,7,8-TCDD as a result of the materials handling, waste disposal, and other operations associated with the pesticide production which has occurred at the site since the 1950's. The proposed remedial action involves excavation of the contaminated areas and redisposal in a secure landfill. These actions would disturb the soil, creating the potential for dust emissions. This study estimates the possible emission rates, uses dispersion models to predict resulting off-site air concentrations, and finally, calculates the exposure/risks caused by these emissions.

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ABSTRACT

The purpose of this study is to assess the risk caused by dust emissions associated with proposed remedial actions considered for the Vertac Chemical Corporation site in Jacksonville, AK. Much of the site is contaminated with 2,3,7,8-TCDD as a result of the materials handling, waste disposal, and other operations associated with the pesticide production which has occurred at the site since the 1950's. The proposed remedial action involves excavation of the contaminated areas and redisposal in a secure landfill. These actions would disturb the soil creating the potential for dust emissions. This study estimates the possible emission rates, uses dispersion models to predict resulting off-site air concentrations, and finally calculates the exposure/risks caused by these emissions.

ASSESSMENT OF RISK CAUSED BY REMEDIAL ACTIONS CONSIDERED FOR VERTAC CHEMICAL CORPORATION SITE, JACKSONVILLE, ARKANSAS

The purpose of this study was to assess the risk caused by the dust emissions associated with the remedial action plans proposed for the Vertac Chemical Corporation site in Jacksonville, AR. The site is contaminated with 2,3,7,8-TCDD which is absorbed to the surface soils. This study was conducted during April-June of 1984 when EPA was negotiating with Vertac to select an appropriate remedy. Specifically, this study estimated the dust concentrations, inhalation exposure and upper bound cancer risk caused by 2,3,7,8-TCDD.

SUMMARY OF RESULTS

The results of this study are best illustrated in Figures 2-17 which diagram the isopleths or lines of equal concentration, exposures and risks around the Vertac facility. Figures 16 and 17 show that the upper bound cancer risk caused by the Alternative IV activities would range from 5×10^{-8} to 7.4×10^{-6} for the nearest residents to the Vertac site.

These estimates were based on the assumption that no dust control measures would be used during the Alternative IV remedial action. The wide range between minimum and maximum estimates is due to the uncertainty in the level of 2,3,7,8-TCDD in the excavated material, which was assumed to be 0.1 to 14 ppm in this study. Before any final decision is made regarding what dust controls and worker protection may be needed during the remedial actions, it is highly recommended that samples be collected from within the excavation areas to more definitively establish these levels.

In summary, the procedures used to estimate the risks involved three steps:

- o Estimation of emission rates - The primary sources of dust emissions were identified as the vehicle travel over contaminated soil, loading/unloading operations and spreading of excavated soil in the new landfill. Standard emission factor equations were used to estimate the emission rates associated with each of these activities.
- o Estimation of ambient dust concentrations - A modified version of the Industrial Source Complex dispersion model was used to calculate the ambient concentrations caused by the emissions.
- o Estimation of exposure and risks - The human exposures resulting from inhalation of contaminated dust particles were calculated using standard Agency procedures. Finally, these exposures were converted to risks using EPA's current estimate of the cancer potency factor for 2,3,7,8-TCDD.

DESCRIPTION OF SITE AND OPTION IV PLANS

The Vertac site is located in Jacksonville, AR about 20 miles northeast of Little Rock, AR. The layout of the buildings and disposal areas are diagrammed in Figure 1. Under Option IV, CH_2M Hill proposed to excavate the Reasor-Hill and North Burial area (this area includes both the old drum storage sites and the Hercules-Transvaal Landfill) and redispose the contaminated soil in a new landfill to be constructed in an area to the north of and overlapping with the North Burial site. Details of the site geology, history, and other background information are presented in depth by CH_2M Hill (1984) and JRB (1984) and will not be repeated here. The reader should consult these documents for further details.

ine surface soil samples collected at the site show 2,3,7,8-TCDD concentrations ranging from 0.1 - 14 ppm (CH_2M Hill, 1984). It was assumed that this range represents the levels that could occur in the proposed excavation areas. Such estimates are best made on the basis of data on the quantity of 2,3,7,8-TCDD disposed, but no such data were available.

The first step under Option IV would be to begin construction of the new landfill which would be built in a series of small cells. As the first cells are completed the excavation and redisposal would proceed in two phases:

- o During the first phase, the Reasor-Hill area would be excavated using a front-end loader. The front-end loader would fill dump trucks which would transport the soil to the new landfill where it would be spread by a bulldozer. During this phase, contaminated dust would be generated at the Reasor-Hill area due to the vehicle travel over contaminated soil and the soil loading operations. Additionally, contaminated dust would be generated at the North Burial area due to the unloading and spreading of contaminated soils. Thus, the dust emissions would originate from two widely separated sources. It was assumed that the road between the two areas would be surfaced with clean dirt and that the trucks would be covered so that contaminated dust emissions would not occur as a result of vehicle travel between sites. Additionally, it was assumed that the wind-only generated dust emissions would be negligible compared to the mechanically generated dust occurring during the travel, loading/unloading, and spreading operations.

- During the second phase, excavation of the North Burial area would occur. The excavated soil would be redisposed in new landfill cells built in the excavated portions of the North Burial area. Thus, all dust emissions would occur from essentially the same place. The activities causing emissions would be identical to those identified under Phase I, i.e., vehicle travel, loading, unloading, and spreading.

CH_2M Hill estimates that 50,000 yd^3 of soil would be excavated from the Reasor-Hill area and 100,000 yd^3 from the North Burial area. The time required to conduct Phases 1 and 2 were estimated as follows (Personal Communication, Jim Howie, CH_2M Hill, May 14, 1984):

1) Dump trucks carry 8 yd^3 and can be filled in 10 minutes. On the basis of 8 working hours/day, 48 loads can be made per day.
2) Time required to excavate Reasor-Hill:
   Working Days = (50,000 yd^3)(1 day/48 loads)(1 load/8 yd^3) = 130 days
   Calendar Days = (130 working days)(365 calendar days/250 working days) = 190 days
3) Time required to excavate North Burial area:
   Working Days = (100,000 yd^3)(1 day/48 loads)(1 load/8 yd^3) = 260 days
   Calendar Days = (260 working days)(365 calendar days/250 working days) = 380 days

EMISSION FACTOR CALCULATIONS

As identified earlier, the dust emissions would occur as a result of three types of activities: vehicle travel, loading/unloading, and spreading. The equations used to model these activities are presented below (EPA, 1983):

1) Travel over contaminated surface:

$$E = k\,(1.7)(s/12)(S/48)(W/2.7)^{.7}(w/4)^{.5}\left(\frac{365-P}{365}\right)$$

where: E = emission factor (kg/vehicle kilometer travel or VKT)

k = particle size multiplier

s = silt content (%)

S = mean vehicle speed (km/hr)

W = mean vehicle weight (million grams or Mg)

w = wheels/vehicle

P = number of days/yr with at least .01 in precipitation

2) Loading/unloading operations:

$$E = k\,(.0018)(s/2)(U/5)(H/5)(M/2)^{-2}(Y/6)^{-.33}$$

where: E = emission factor (lb/ton)

k = particle size multiplier

s = silt content (%)

U = mean wind speed (mph)

H = drop height (ft)

M = moisture content (%)

Y = dumping device capacity (yd^3)

3) Spreading (assumed similar to tilling):

$$E = k\,(5.38)s^{.6}$$

where: E = emission factor (kg/hectare)

k = particle size multiplier

s = silt content (%)

The parameter value assumptions used in these equations are explained below:

- Silt Content - As used in this study, silt content refers to the portion of the soil which will pass through a 200 mesh screen during dry sieving. In agricultural applications silt is measured by first using a surfactant solution to completely disaggregate soil particles. However, for purposes of estimating dust emissions, silt content is better measured using the dry sieving technique which gives much lower silt values than the wet technique. Soils in the Jacksonville area are reported to have a silt content of 70-90% on basis of the wet measurement technique (Personal Communication from Larry Ward, U.S. Soil Conservation Service, Little Rock, AR, May 18, 1984). Although no confirmed measurements of silt on a dry sieving basis could be found for the Vertac area, it rarely exceeds 30% (Personal Communication from Chatten Cowherd, Midwest Research Institute, Kansas City, MO. May 17, 1984). Thus, 30% was selected for use in this study.
- The assumptions below regarding vehicle characteristics represent typical construction equipment (Personal Communication, Chris Cole, Midwest Research Institute, Kansas City, MO. May 16, 1984):

Parameter	Front-End Loader	Dump Truck
Mean Weight (lb)	21,300	-
Mean Speed (mph)	5	5
No. of Wheels	4	-
Load Capacity (yd^3)	2	8

Drop Heights:

Front-end loader to truck - 2 ft

Truck to ground - 4 ft

- o The number of days/yr that precipitation is at least .01 inch was assumed equal to 105 days on the basis of national meteorologic data presented by EPA (1983).
- o The particle size multiplier was chosen for the <10 u size particles. This range is generally considered the "respirable" range since most larger particles are not inhaled. Additionally, the larger particles have faster settling velocities and are only important very close to the source. The multiplier as reported by EPA (1983) is given below for each activity type:

Activity	Particle Size Multiplier
Vehicle Travel	.45
Loading/Unloading	.36
Spreading (tilling)	.21

- o The mean wind speed in the Little Rock area was assumed equal to 3.6 m/sec or 8.0 mph (Cowherd et al. 1984).
- o Moisture content was assumed equal to 12% on basis of parent soils in Jacksonville area (Personal Communication from Larry Ward, U.S. Soil Conservation Service, Little Rock, AR, May 17, 1984).

On the basis of the above parameter values the following emission factors were evaluated:

- o Front-end loader travel during excavation: E = .63 kg/VKT

- Truck loading: $E = 9.93 \times 10^{-5}$ lb/ton
- Truck unloading: $E = 1.26 \times 10^{-5}$ lb/ton
- Spreading: $E = 8.69$ kg/ha

The parameter values used to obtain these estimates are summarized in Table 1.

CALCULATION OF EMISSION RATES DURING PHASE 1

The dust emissions occurring during Phase 1 involve both the excavation activities at the Reasor-Hill area and the disposal operations at the North Burial site as explained earlier. The emission rate at the Reasor-Hill landfill result from the front-end loader travel and truck loading operations. The front-end loader travel emissions were calculated on the assumption that it will travel 40 ft/load (Personal Communication from Jim Howie, CH_2M Hill, Inc. May 14, 1984). The total travel distance is calculated as follows:

$$\text{Front-end loader} = (40 \text{ ft/load})(3.05 \times 10^{-4} \text{ km/ft})(50{,}000 \text{ yd}^3)(1 \text{ load}/2 \text{ yd}^3)$$

$$= 305 \text{ km}$$

Using the above and averaging the emissions over the calendar days which they occur yields the following emission rate:

$$\text{Front-end loader} = \frac{(.63 \text{ kg/VKT})(305 \text{ VKT})(10^3 \text{ g/kg})}{(190 \text{ days})(24 \text{ hr/day})(3600 \text{ sec/hrs})}$$

$$= 1.17 \times 10^{-2} \text{ g/sec}$$

Similarly, the emissions occurring during the truck loading are calculated as follows:

$$\text{Truck loading Emission rate} = \frac{(9.93 \times 10^{-5} \text{ lb/ton})(50{,}000 \text{ yd}^3)(1.1 \text{ tons/yd}^3)(454 \text{ g/lb})}{(190 \text{ days})(24 \text{ hr/day})(3600 \text{ sec/hr})}$$

$$= 1.51 \times 10^{-4} \text{ g/sec}$$

The above emission rates represent the total dust* emitted. Assuming the 2,3,7,8-TCDD concentrations in soil and suspended particulates are the same, the 2,3,7,8-TCDD concentration in the air can be calculated by multiplying the total dust level by the 2,3,7,8-TCDD levels in the soil. As explained earlier, this is assumed to range from .1 to 14 ppm. Making these multiplications and summing the emissions from the front-end loader travel and truck loading give a total of 1.18×10^{-9} to 1.65×10^{-7} g/sec of 2,3,7,8-TCDD from the Reasor-Hill area.

The emissions at the North Burial area result from the unloading and spreading operations. The emissions from the unloading are calculated in an identical fashion to those calculated for the loading. All parameter values are the same except the emission factor resulting in a slightly greater total dust* emission rate of 1.91×10^{-4} g/sec.

The emissions from the spreading are calculated from estimations of the area over which the material is spread. This was based on the assumption that each truck load would be spread 50 ft x 10 ft (Personal Communication from Jim Howie, CH_2M Hill, Inc. May 18, 1984):

$$\text{Total Spread Area} = (50{,}000\ yd^3)(1\ load/8\ yd^3)(500\ ft^2/load)(9.29 \times 10^{-6}\ ha/ft^2)$$

$$= 29\ ha$$

Now, the emissions can be calculated:

$$\text{Emission Rate from Spreading} = \frac{(8.69\ kg/ha)(29\ ha)(10^3\ g/kg)}{(190\ days)(24\ hr/day)(3600\ sec/hr)}$$

$$= 1.53 \times 10^{-2}\ g/sec$$

*Total dust emissions refers to the less than 10 u size particles and is used distinguish it from the 2,3,7,8-TCDD portion of the dust emissions.

Summing these total dust emission rates and multiplying by the contaminant concentration gives a range of the 2,3,7,8-TCDD average emission rate as 1.55×10^{-9} to 2.17×10^{-7} g/sec occurring from the North Burial area during Phase 1.

CALCULATION OF EMISSION RATES DURING PHASE 2

As explained earlier, during Phase 2 all dust emissions occur at the North Burial area. The same activities occur as do in Phase 1, but over a period twice as long and involve excavation and disposal of twice as much material. The emission rate associated with each activity is the same as calculated for Phase 1.

Thus, the total emissions occurring at the North Burial areas during Phase 2 is simply the sum of the emission rates estimated earlier for each of the four activities. Accordingly, the 2,3,7,8-TCDD average emission rate ranges from 2.3×10^{-9} to 3.8×10^{-7} g/sec.

CALCULATION OF AMBIENT CONCENTRATIONS

The dispersion effects were calculated by using a method developed by Cowherd et al. (1984) specifically for application to ground level area source particulate emissions. This method was derived from the Industrial Source Complex - Long Term (ISCLT) model. Use of it in this study requires two critical assumptions:

- The meteorologic conditions in the Vertac area are similar to those assumed in the model which were averaged from a wide region encompassing much of the central U.S.

- o The source size assumed in the model (2.5 acres) is representative of the source size at Vertac. Although the excavation areas are larger than 2.5 acres (i.e., Reasor-Hill area - 6 acres and North Burial area - 12 acres) the actual areas under construction at one time will be much smaller.

It was also assumed that the site had no unusual topography which could effect dispersion.

For the Phase 1 calculations the dispersion model was applied to the Reasor-Hill and North Burial areas individually since the two areas are widely separated. Using the average concentrations* predicted by the modeling, concentration isopleths of the ambient air TCDD concentrations resulting from the Phase 1 excavation were constructed as follows:

1) Concentration isopleths of ambient air TCDD concentrations resulting from excavation of soil at Reasor-Hill landfill were estimated using emission rates for vehicle travel and loading activities.
2) Concentration isopleths of ambient air TCDD concentrations resulting from disposal of contaminated soils at the North Burial area were estimated using emission rates for unloading and spreading activities.
3) Isopleths drawn in step 2 were overlayed on isopleths drawn in step 1. Where overlap of isopleths occurred ambient concentrations were added. These areas are shown as solid lines in Figures 2 and 3.

*The concentration estimates represent averages over the entire length of the remedial action program since they are based on emission rates which represent averages over the same period.

4) North of the overlapping isopleths, the concentration of the outermost isopleth drawn in step 1 was added to the concentrations of the isopleths drawn in step 2. This area is shown as dashed lines in the top portion of Figures 2 and 3. This procedures overestimates TCDD air concentrations, exposures and upper bound lifetime cancer risks in this region.

5) South of the overlapping isopleths, the concentration estimated at the southern most point in step 2 was added to the isopleths drawn in step 1. This area is shown as dashed lines in the bottom portion of Figures 2 and 3. This procedure overestimates TCDD air concentrations, exposures and upper bound lifetime cancer risk in this region.

For the Phase 2 calculations the dispersion model was applied to the North Burial area only since it is the only source during this phase. The minimum and maximum isopleths are illustrated in Figures 4 and 5.

EXPOSURE CALCULATIONS

Ambient air dust concentrations can cause human exposure via inhalation. The potential exposure levels were calculated as follows:

$$\text{Average Lifetime Exposure} = \frac{(\text{TCDD Concentration})(\text{Respiration Rate})(\text{Exposure Duration})}{(\text{Body Weight})(\text{Lifetime})}$$

The parameter value assumptions are explained below:

- The TCDD concentrations were based on the estimates explained earlier.
- The respiration rate was assumed equal to 23 m^3/day (Snyder 1975). This value reflects the portions of the day that a person is resting and engaged in light activity. Emission rates and concommitant atmospheric concentrations of 2,3,7,8-TCDD were calculated for an 8 hour operational day. These rates and concentrations were reduced by a

factor of 3 to estimate an average 24 hour emissions rate and atmospheric concentration.*

- Exposure duration was assumed to correspond to the calendar days over which the exposure occurs, i.e., 190 for Phase 1 and 380 for Phase 2. Hence, daily average emissions and concentrations were reduced by a factor of 5/7 to provide an estimate of average calendar day emissions and concentrations as opposed to average operating day emissions and concentrations.*
- The bodyweight was assumed equal to 70 kg which represents an average adult male (Abraham, 1979). This further implies that this bodyweight is continuous over an individual's lifetime.
- The lifetime was assumed equal to 70 yr.

Additionally, this approach assumes that all of the inhaled 2,3,7,8-TCDD is absorbed into the body. Since the concentrations reflect only <10 u particles, virtually all of these particles would be inhaled. Although some of the smallest particles would be exhaled, they represent a small mass fraction of the total. Using the exposure calculations explained above, isopleths of equal exposure levels were calculated for each phase and the combined phases. The isopleth locations correspond exactly to the concentration isopleths calculated earlier. The minimum and maximum exposures for Phase 1 are illustrated in Figures 6 and 7. The minimum and maximum exposures for Phase 2 are illustrated in Figures 8 and 9. Finally, the minimum and maximum exposures for the combined case are

*Such long term averaging is appropriate for assessing chronic health effects on the basis of lifetime dose per unit body weight. Also, it provides computational convenience.

illustrated in Figures 10 and 11. The combined phase exposure are shown only for the area below Vertac's southern property line where the nearest residents are located.

RISK CALCULATIONS

The increased cancer risk is calculated as follows:

Upper Bound
Increased Cancer = 1-exp [-Lifetime Average Daily Exposure x Cancer Potency Factor]
Risk

The cancer potency factor (or 95% upper limit of the linear coefficient in the dose-response model) for 2,3,7,8-TCDD has been estimated as .156 $(ng/kg\text{-}day)^{-1}$ (EPA, 1984). In order to use the above equation properly it is important that the derivation of the potency factor and exposure calculation treat absorption into the body in a consistent fashion. The exposure estimates presented in this document represent the amount of 2,3,7,8-TCDD absorbed into the body. The potency factor, however, was derived on the basis of the administered dose (total ingested by test animals). Thus, an adjustment is needed. The potency factor was derived from a study where the TCDD was administered to rats via their feed. Fries and Marrow (1975) report that approximately 50% of the TCDD in feed is absorbed into rats. Accordingly, the potency based on dose administered via feed must be multiplied by 2 to yield a potency based on absorbed dose. This adjustment provides consistent potency and exposure estimate. Accordingly, the potency was multiplied by 2 to yield an adjusted potency of .312 $(ng/kg\text{-}day)^{-1}$. Using this adjusted potency and the exposure levels calculated earlier, risks were calculated and plotted as isopleths for each phase and the combined case. Figures 12 and 13 show the

risk isopleths for Phase 1. Figures 14 and 15 show the risk isopleths for Phase 2. Finally Figues 16 and 17 show the risk isopleths for the combined phases. As with exposure, the combined phase risks are shown only for the area below the Vertac's southern property line where the nearest residents are located.

SOURCES OF UNCERTAINTY

The final range of risk estimates span two orders of magnitude. Although the information needed to analyze the uncertainty on a statistical basis is unavailable, this range appears representative of the uncertainty in these types of calculations.

The uncertainty is derived partially from the fact that the parameter value assumptions may not reflect actual conditions. For example, the assumptions regarding TCDD concentration in the soil, silt content, volume of excavated soil, moisture content of the soil, percent TCDD absorbed into the body and the cancer potency estimate all have some uncertainty associated with them. Additionally, uncertainty is introduced by the fact that the calculational procedures may not represent the actual processes accurately. The emission factor equations and dispersion model have been extensively tested and validated but are still subject to some uncertainty. The exposure and risk equation represent the state-of-the-art in this field, but also introduce uncertainty.

Such uncertainty is unavoidable in these types of calculations and reveals the importance of further monitoring. Measurement of actual TCDD levels in the air during any remedial actions would allow confirmations of the risk predictions.

CONCLUSIONS

Figures 16 and 17 show that the upper bound estimated cancer risk associated with implementation of Alternative IV remedial actions would range from 5×10^{-8} to 7.4×10^{-6} for the nearest residents to Vertac. These upper bound estimates of risk are associated with inhalation of 2,3,7,8-TCDD contaminated dust. Such risks would decline with distance from the site.

The wide range between the minimum and maximum estimates of upper bound risks is due primarily to the uncertainty in the level of 2,3,7,8-TCDD in the excavated material which was assumed to vary from 0.1 to 14 ppm. Because of this wide range of uncertainty, further monitoring of the area would be necessary to specify the worker protection and dust control requirements. It is also recommended that dust samples be collected during the remedial action to confirm the projections made in this study.

TABLE 1. SUMMARY OF PARAMETER VALUES USED TO CALCULATE EMISSION FACTORS

Vehicle Travel	
Particle Size Multiplier	0.45
Silt Content (%)	30
Mean Vehicle Speed (km/hr)	8
Mean Vehicle Weight (Mg)	11.7
Wheels/Vehicle	4
Days Exceeding 0.01 in Precipitation (days/yr)	105
Truck Loading	
Particle Size Multiplier	0.36
Silt Content (%)	30
Mean Wind Speed (mph)	8
Drop Height (ft)	2
Moisture Content (%)	12
Dumping Device Capacity (yd^3)	2
Truck Unloading	
Particle Size Multiplier	0.36
Silt Content (%)	30
Mean Wind Speed (mph)	8
Drop Height (ft)	4
Moisture Content (%)	12
Dumping Device (yd^3)	8
Spreading	
Particle Size Multiplier	0.21
Silt Content (%)	30

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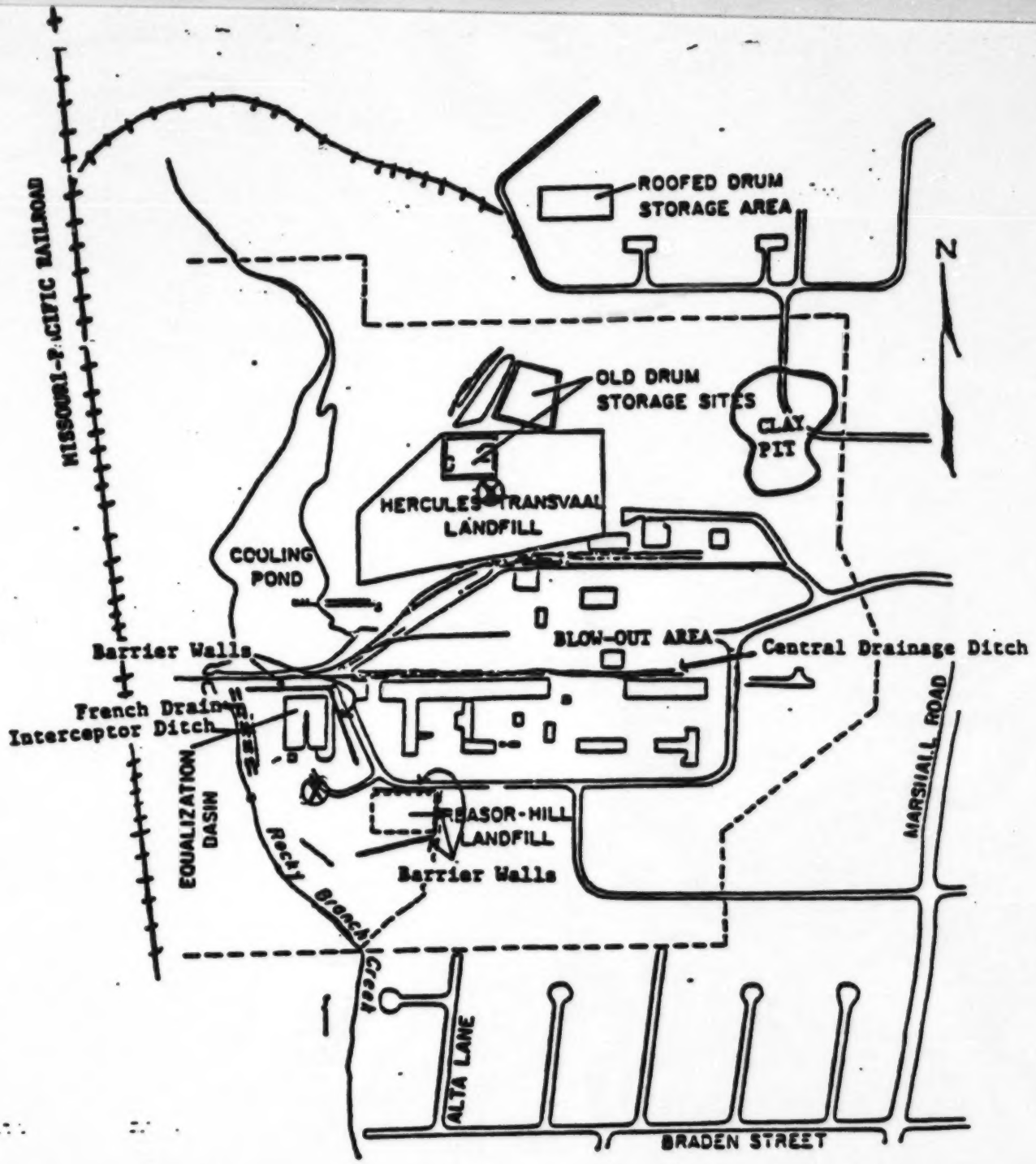


Scale: 1 in. = 145 meters

⊗ - Center of Dust Emission Source

— — — — — Property Line

Figure 1 - Vertac Site and Surrounding Area

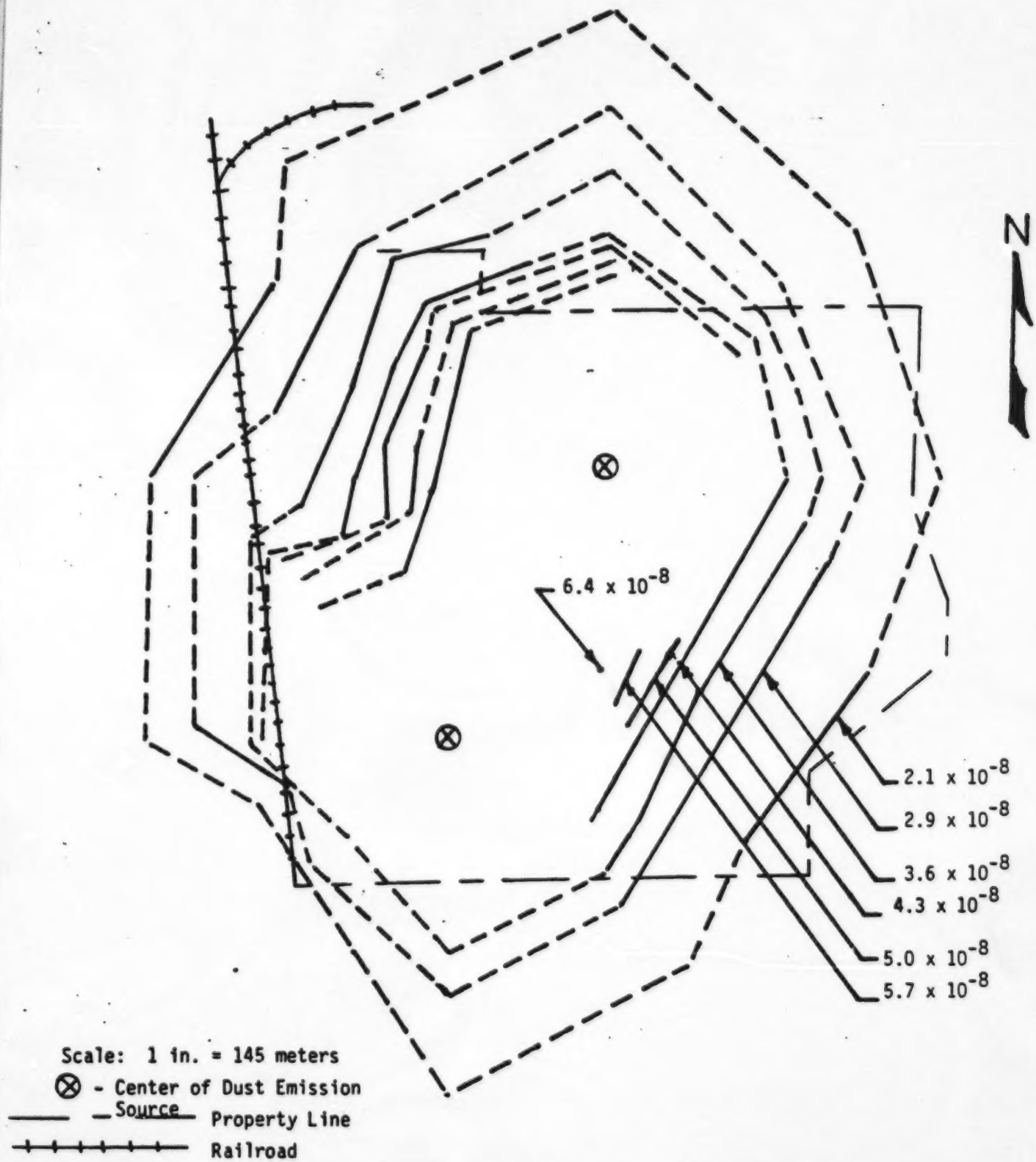


FIGURE 2. MINIMUM TCDD CONC (ug/M^3) IN AIR RESULTING FROM PHASE 1 ACTIVITIES

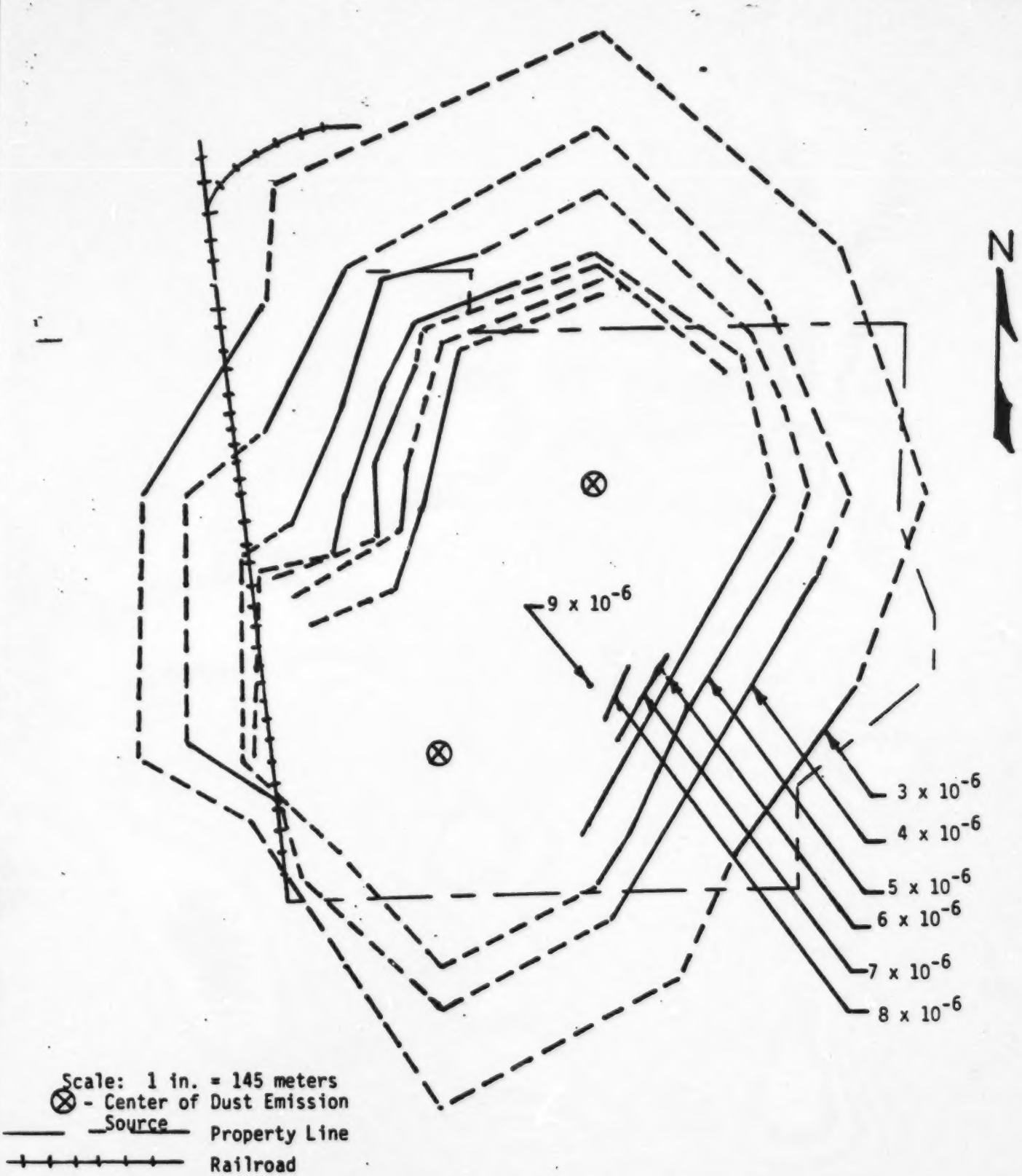
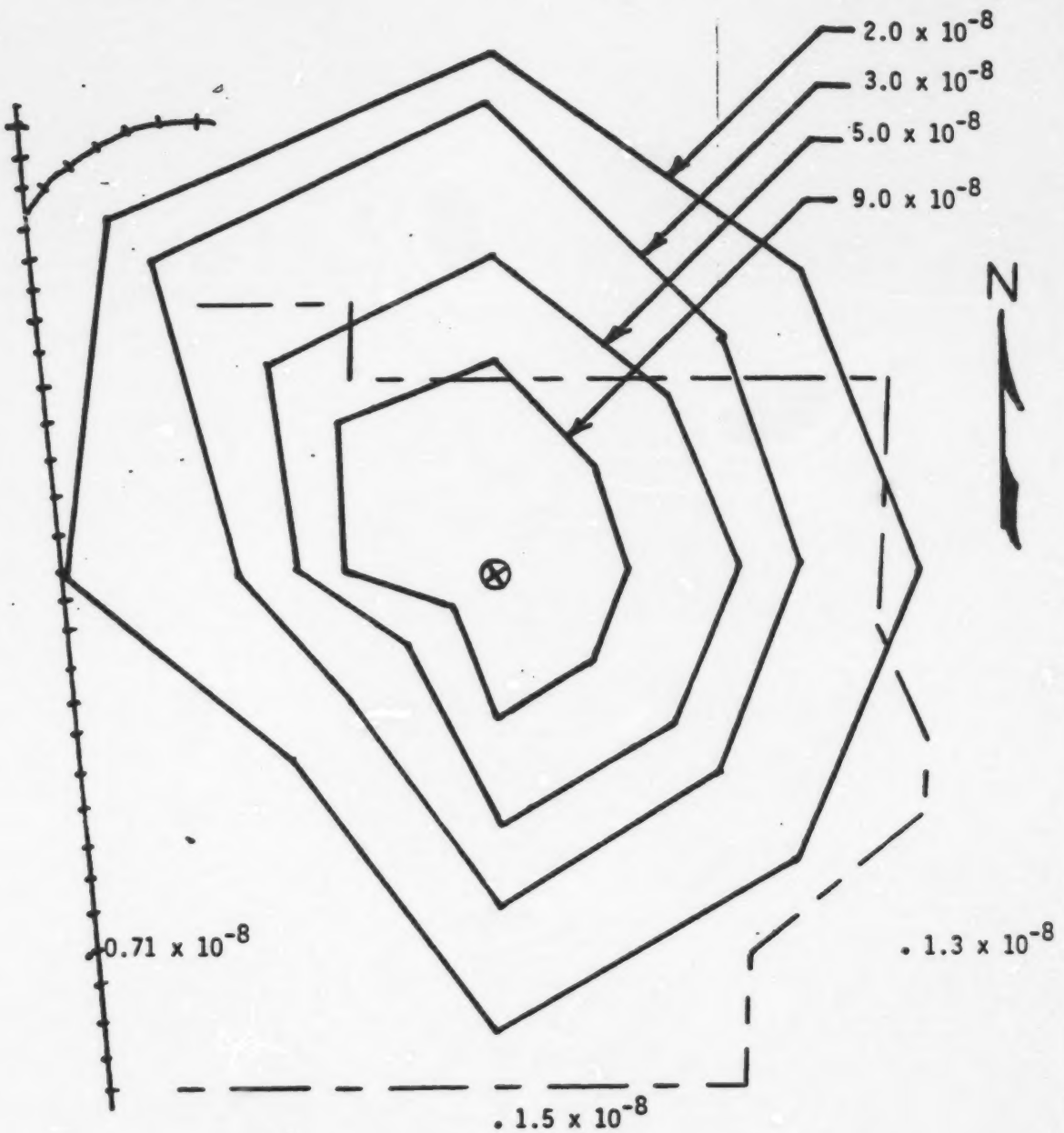


FIGURE 3. MAXIMUM TCDD CONC (ug/M^3) IN AIR RESULTING FROM PHASE 1 ACTIVITIES



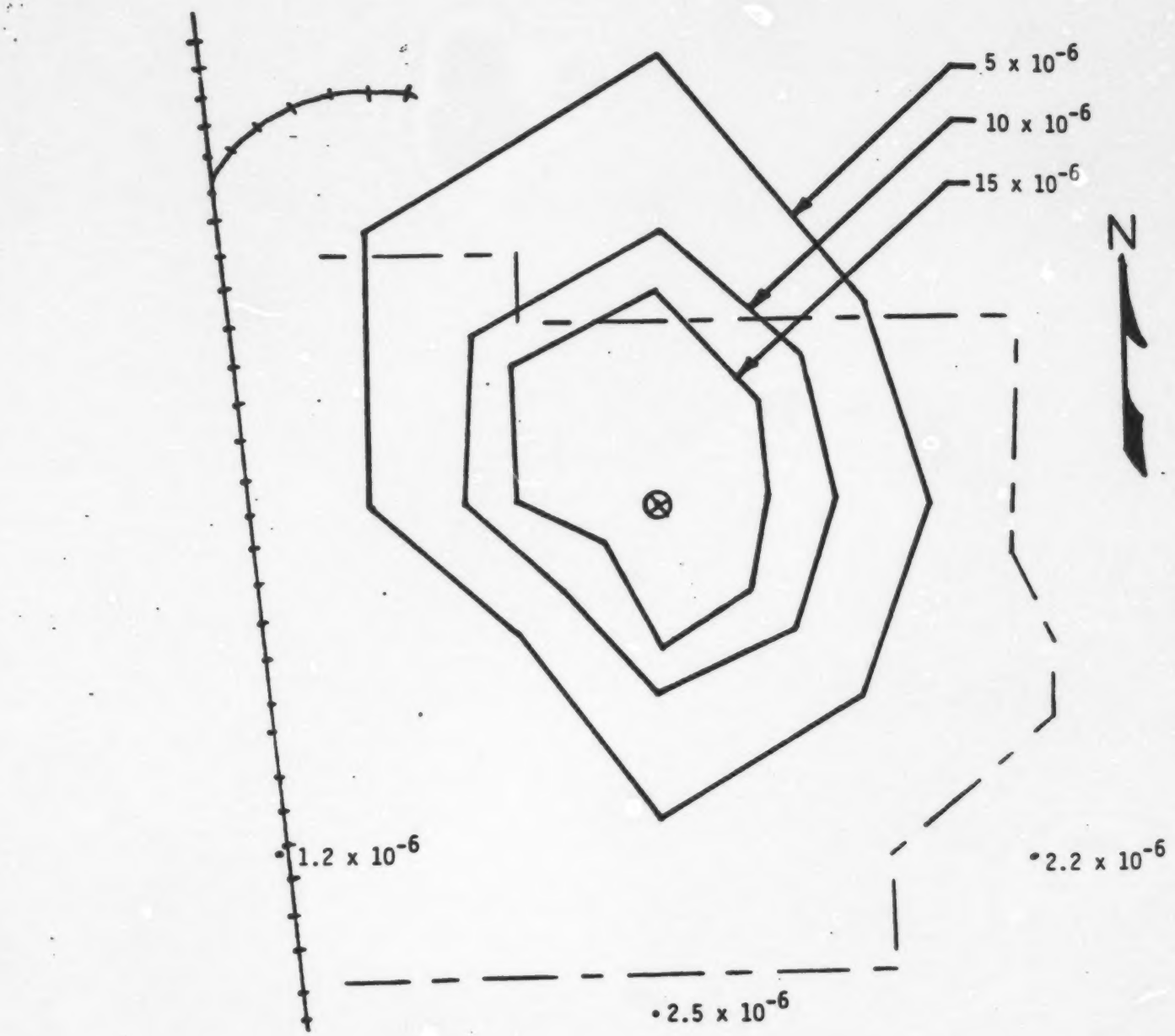
Scale: 1 in. = 145 meters

⊗ Center of Dust Emission Source

——— — ——— Property Line

+++++++ Railroad

FIGURE 4. MINIMUM TCDD CONC (ug/M^3) IN AIR RESULTING FROM PHASE 2 ACTIVITIES



Scale: 1 in. = 145 meters

⊗ Center of Dust Emission Source

——— — ——— Property Line

+++++++ Railroad

FIGURE 5. MAXIMUM TCDD CONC (ug/M^3) IN AIR RESULTING FROM PHASE 2 ACTIVITIES

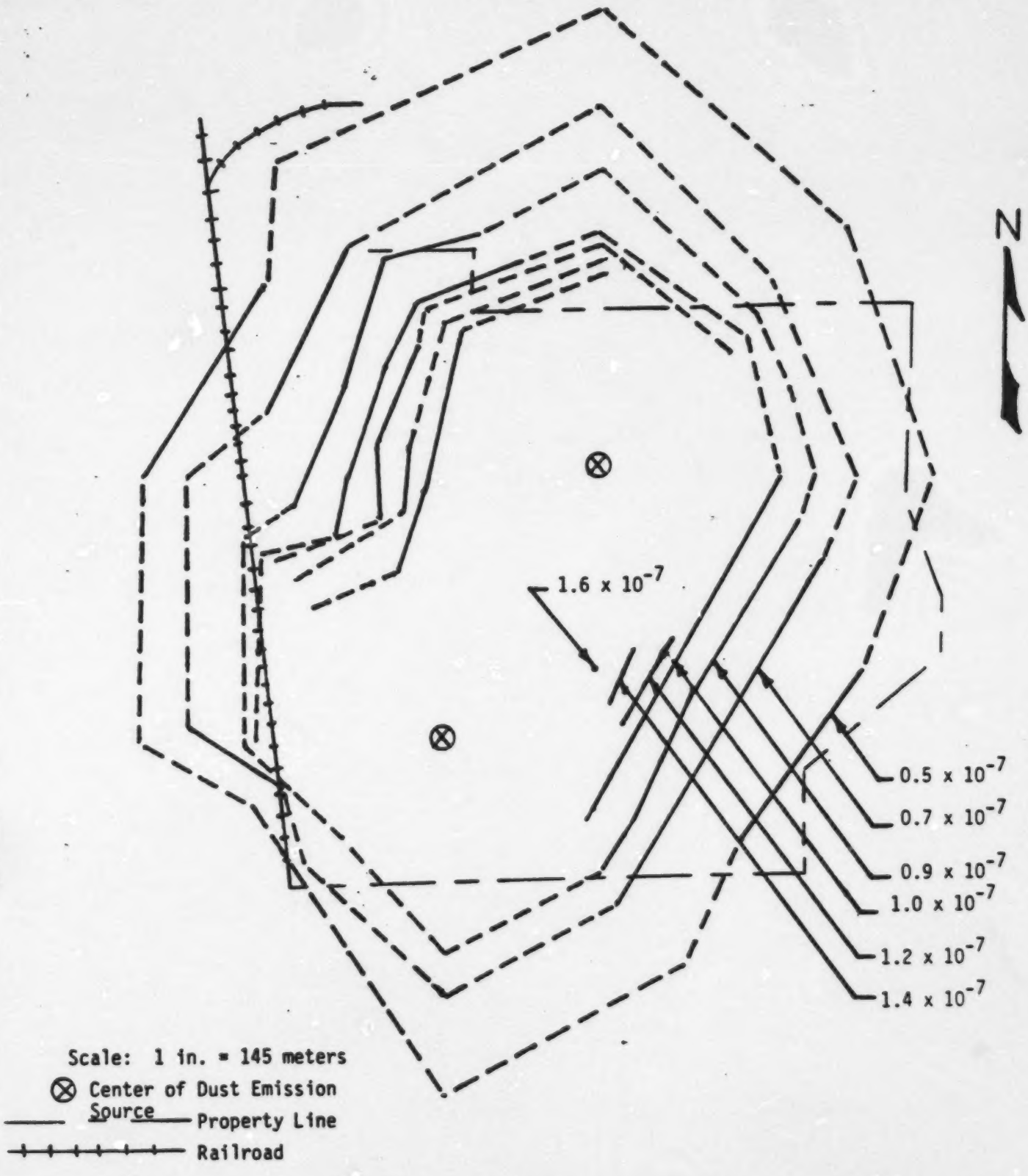


FIGURE 6. MINIMUM EXPOSURES (ng/Kg-day) RESULTING FROM PHASE 1 ACTIVITIES

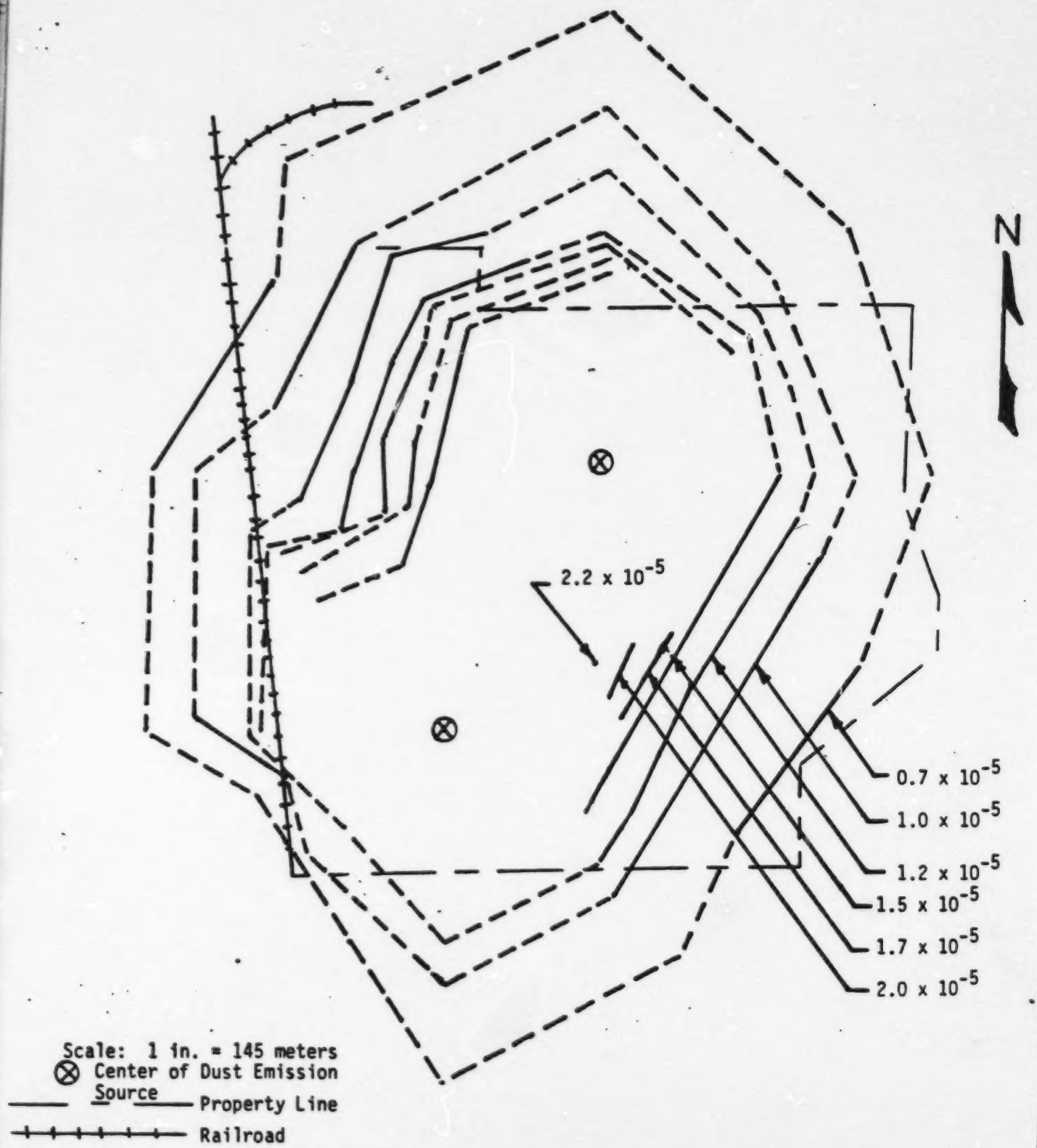


FIGURE 7. MAXIMUM TCDD EXPOSURES (ng/kg-day) RESULTING FROM PHASE 1 ACTIVITIES

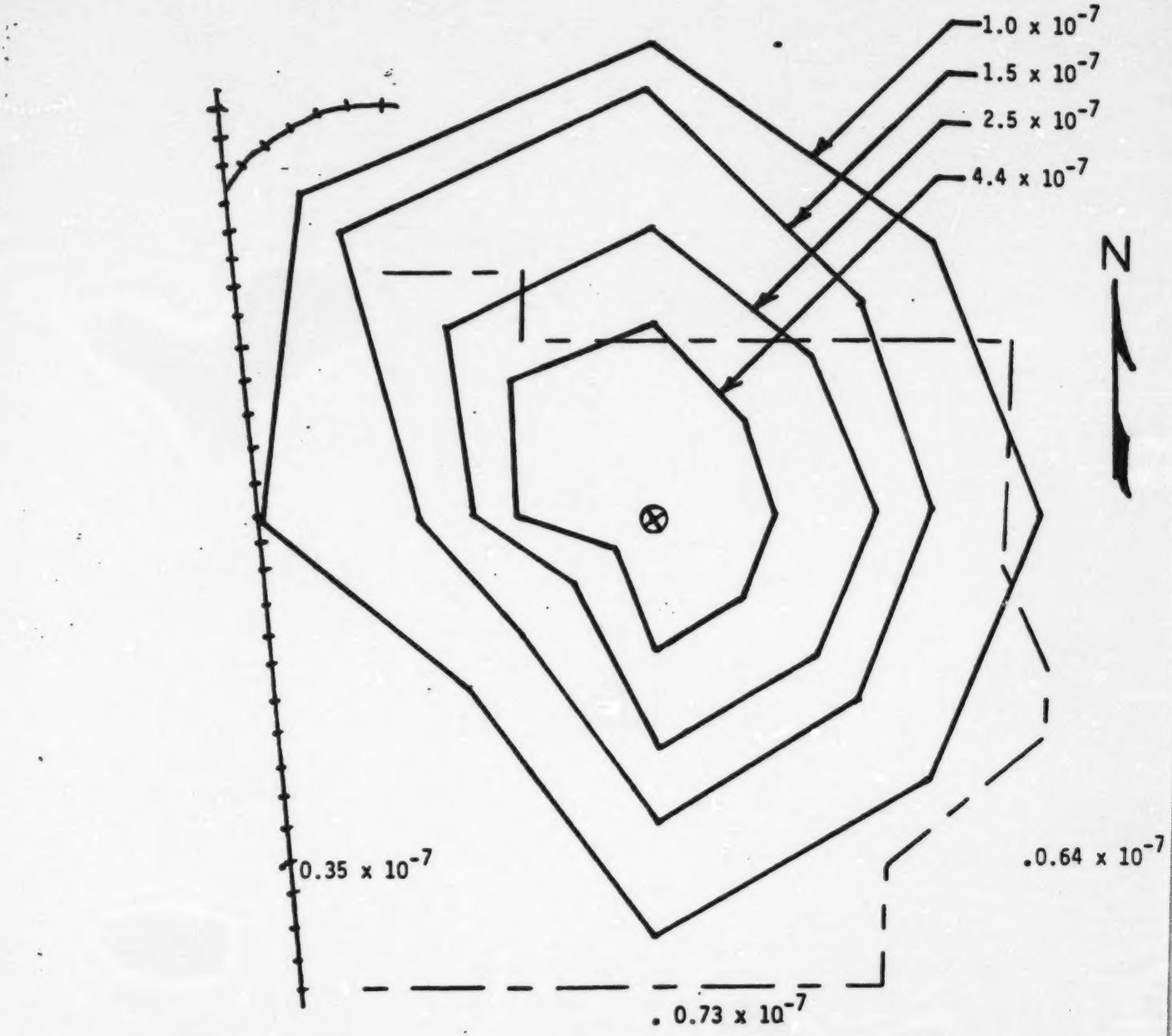
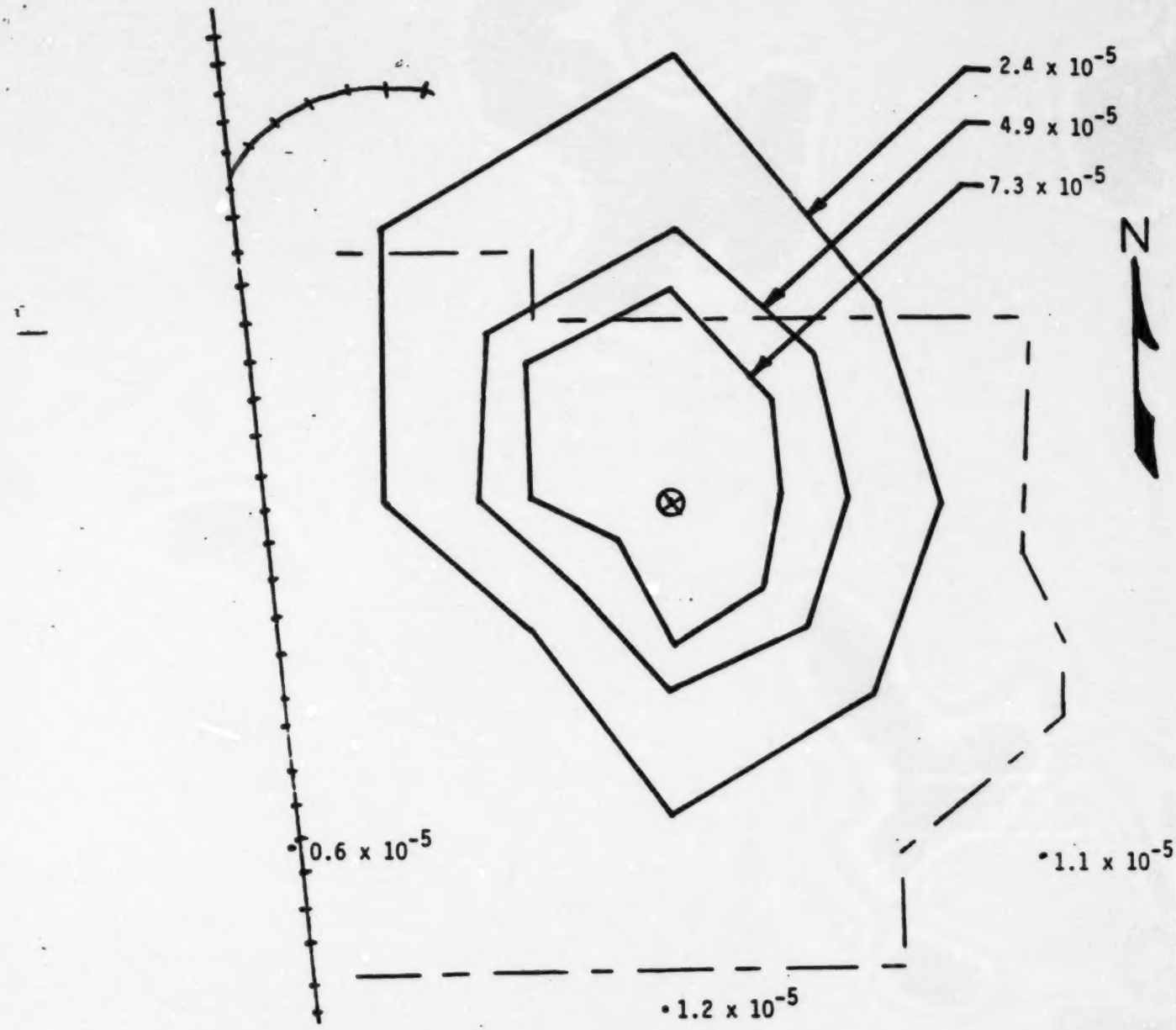


FIGURE 8. MINIMUM TCDD EXPOSURE (ng/kg-day) RESULTING FROM PHASE 2 ACTIVITIES

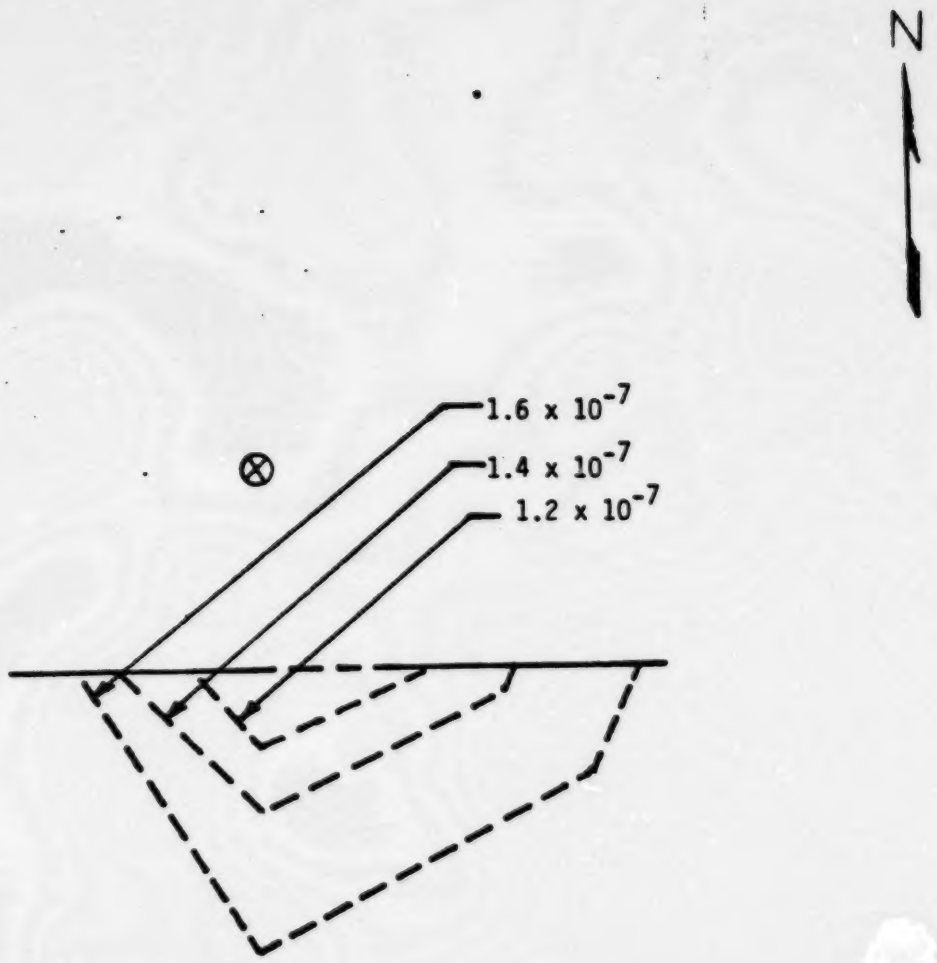


Scale: 1 in. = 145 meters
⊗ Center of Dust Emission Source

——— — ——— Property Line

+ + + + + + Railroad

FIGURE 9. MAXIMUM TCDD EXPOSURE (ng/kg-day) RESULTING FROM PHASE 2 ACTIVITIES



Scale: 1 in. = 145 meters

⊗ Center of Dust Emission Source

——— – – ——— Property Line

FIGURE 10. MINIMUM ACCUMULATIVE EXPOSURE (ng/kg-day) IMMEDIATELY SOUTH OF THE VERTAC PROPERTY (RESULTING FROM THE COMBINATION OF PHASES 1 AND 2 ACTIVITIES)

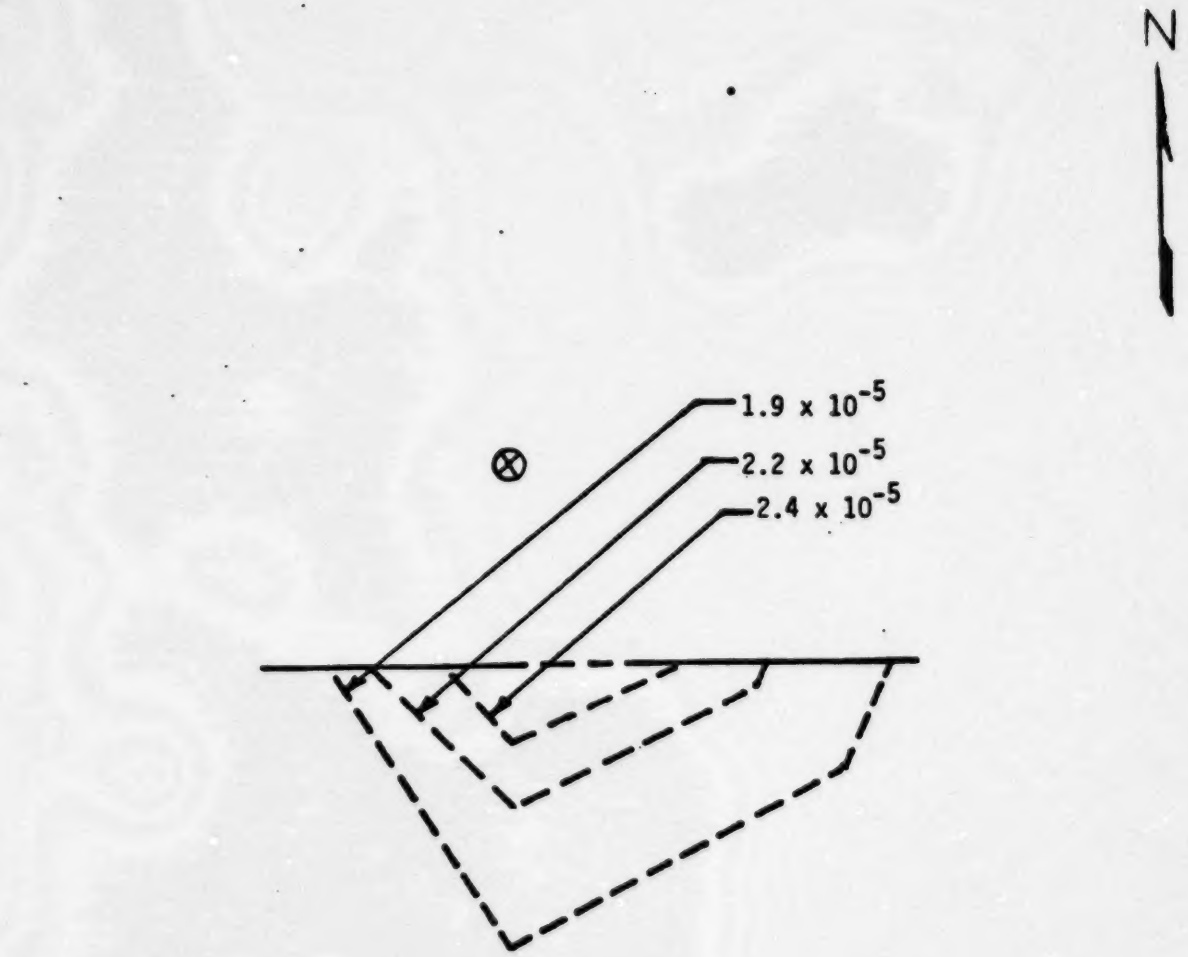


FIGURE 11. MAXIMUM ACCUMULATIVE EXPOSURE (ng/kg-day) IMMEDIATELY SOUTH OF THE VERTAC PROPERTY (RESULTING FROM THE COMBINATION OF PHASES 1 AND 2 ACTIVITIES)

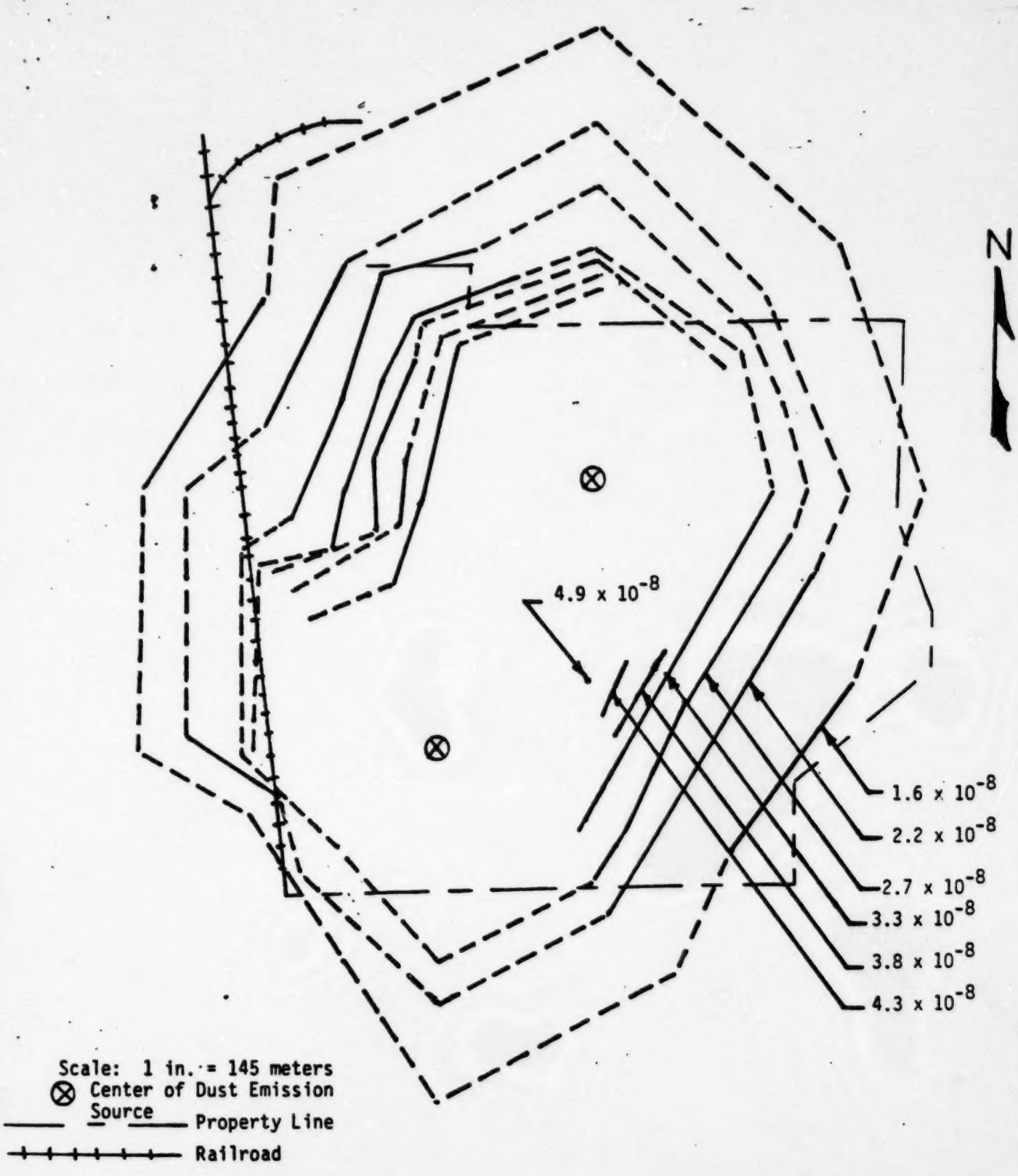


FIGURE 12. MINIMUM RISK LEVELS RESULTING FROM PHASE 1 ACTIVITIES

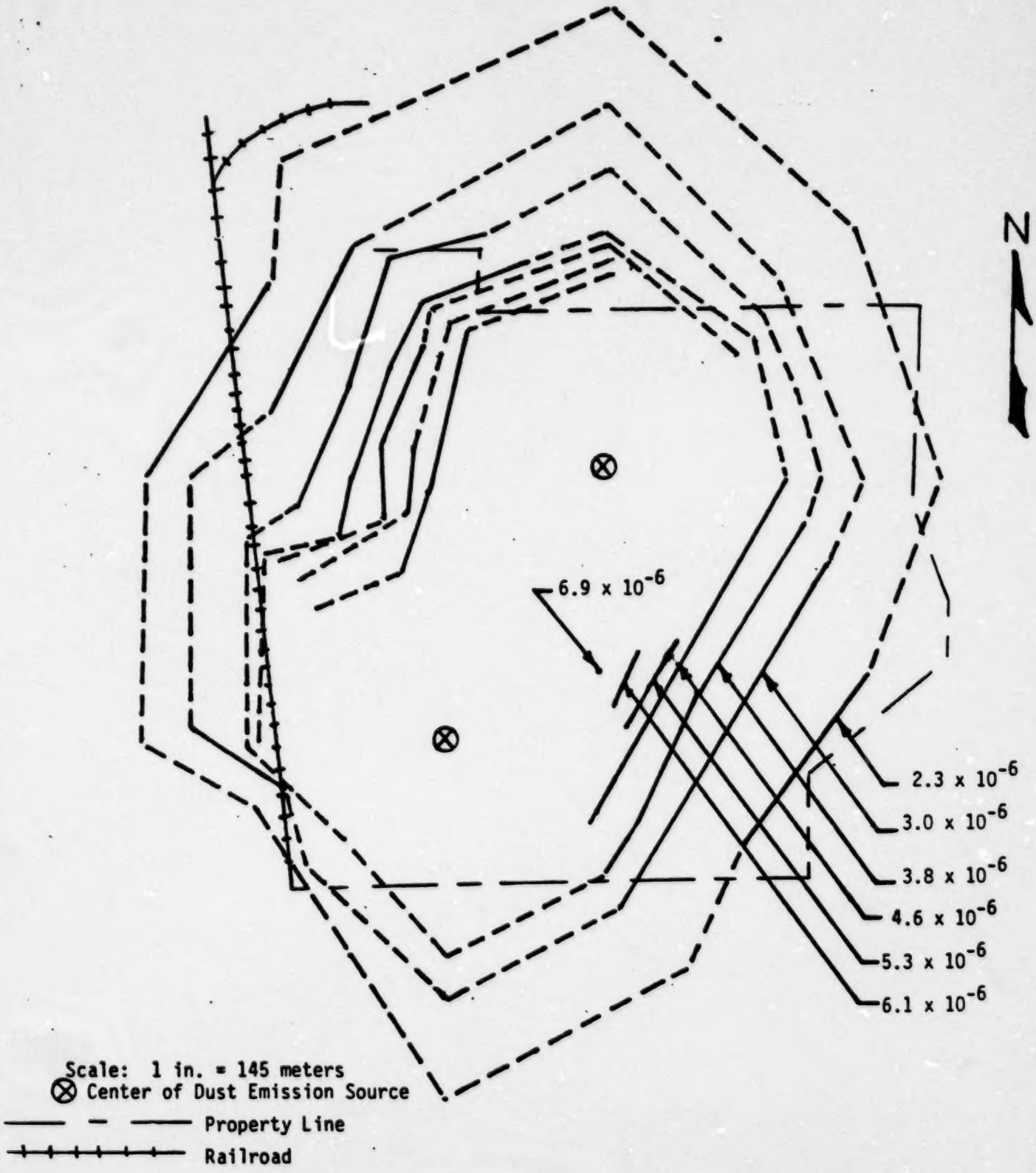


FIGURE 13. MAXIMUM RISK LEVELS RESULTING FROM PHASE 1 ACTIVITIES

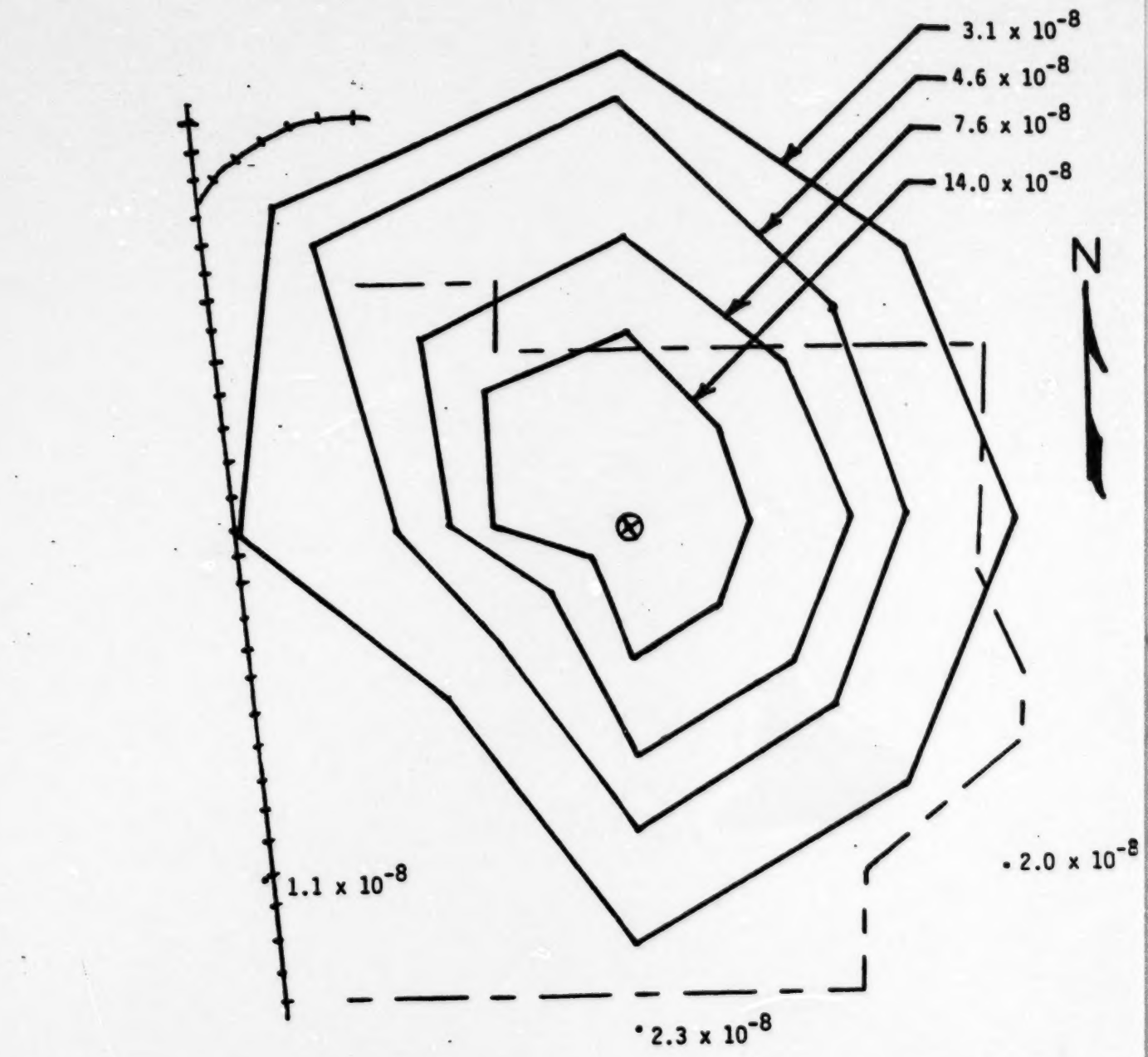


FIGURE 14. MINIMUM RISK LEVELS RESULTING FROM PHASE 2 ACTIVITIES

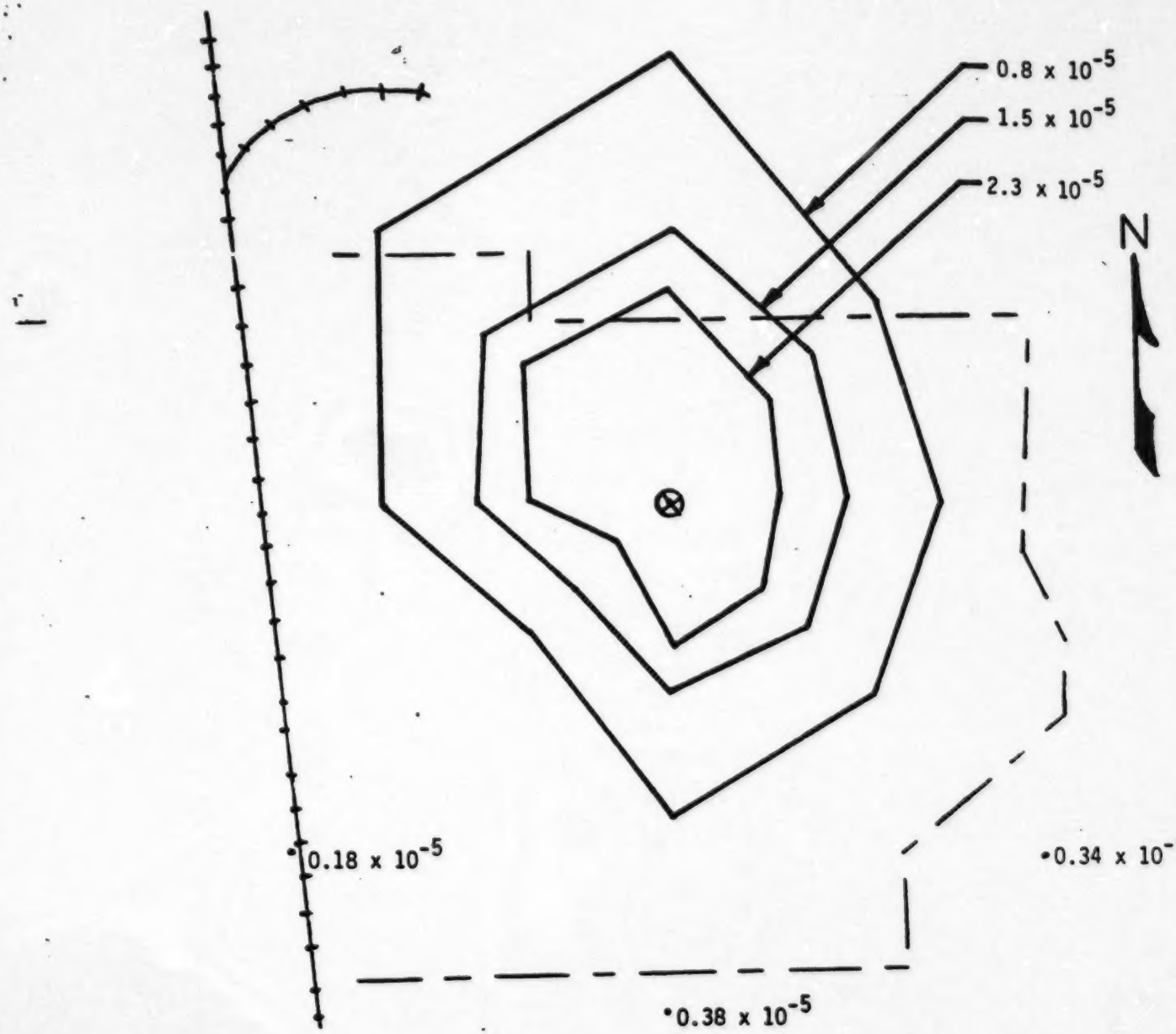
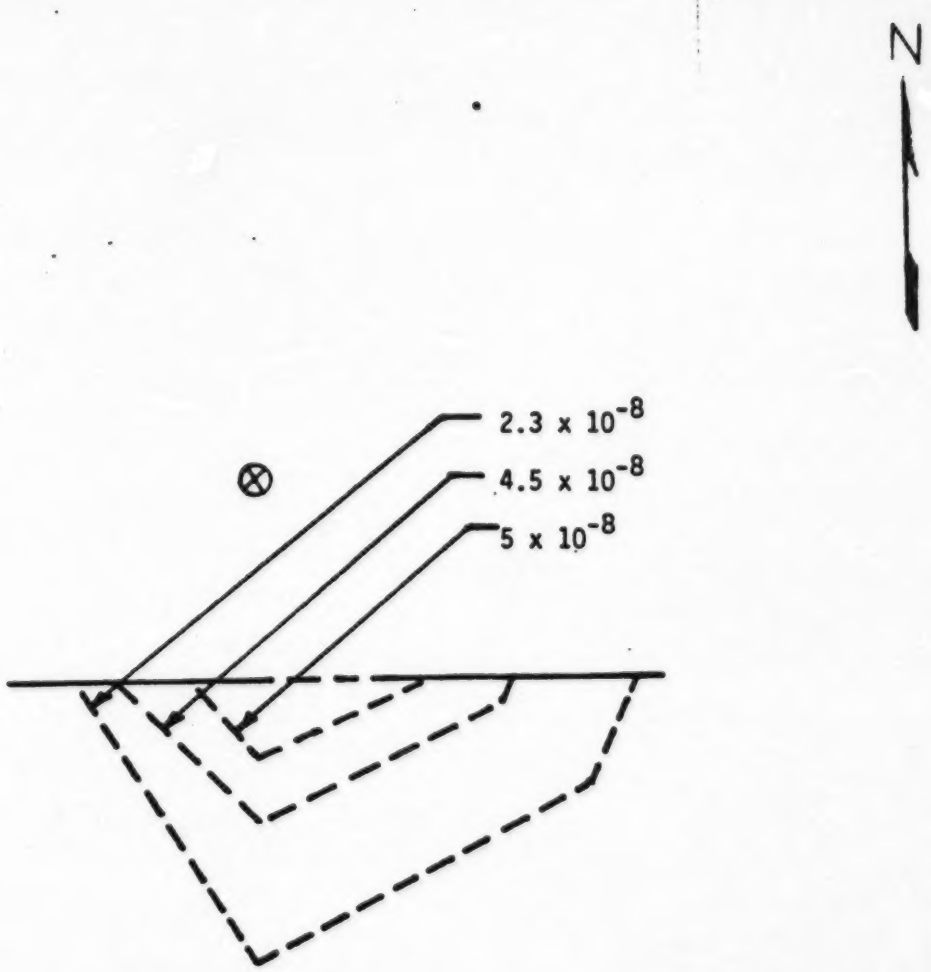


FIGURE 15. MAXIMUM RISK LEVELS RESULTING FROM PHASE 2 ACTIVITIES

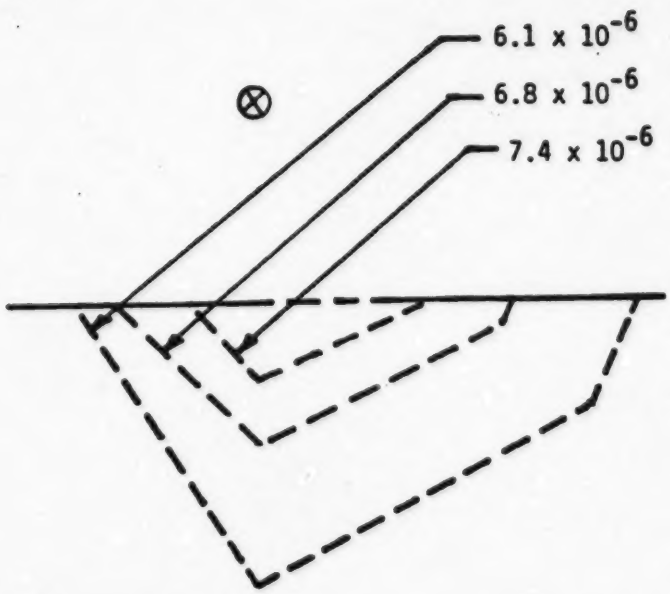


Scale: 1 in. = 145 meters

⊗ Center of Dust Emission Source

——— – – ——— Property Line

FIGURE 16. MINIMUM ACCUMULATIVE UPPER BOUND RISK ESTIMATE IMMEDIATELY SOUTH OF THE VERTAC PROPERTY (RESULTING FROM THE COMBINATION OF PHASE 1 AND 2 ACTIVITIES)



Scale: 1 in. = 145 meters

⊗ Center of Dust Emission Source

——— – – ——— Property Line

FIGURE 17. MAXIMUM ACCUMULATIVE UPPER BOUND RISK ESTIMATE IMMEDIATELY SOUTH OF THE VERTAC PROPERTY (RESULTING FROM THE COMBINATION OF PHASES 1 AND 2 ACTIVITIES)